SCIENTIFIC KNOWLEDGE IN THE NORTH IN THE THIRTEENTH CENTURY.

Among the many problems that we meet in the study of medieval documents one of the more important and more difficult is the question of sources. If the author did not have first-hand knowledge, where did he get his information? This question is especially pertinent in the case of a work that pretends to deal with scientific data. The Old Norwegian document, the *Speculum Regale* or "King's Mirror" is no exception to the general rule; its author gives only indirect information as to his sources and in our own efforts to determine them we meet an added difficulty in the fact that he has carefully concealed his identity.

Some time ago I had occasion to compare the description of Ireland in the King's Mirror with that of Giraldus Cambrensis in the *Topography of Ireland* and found that the Welshman had been closely followed both in plan and details, though the Norse writer also had information that Gerald did not possess, or at least did not use in his account. These conclusions were presented at the annual meeting of this society in 1912. Later it occurred to me that the author of the Mirror might have used other writings of British origin. The first part of his work deals with matters that were of interest to the sea-faring merchants of the age, such as the tides and the winds, the seasons best suited to navigation, the five zones, the length of the year, and the like. Most of these things the author evidently knew from experience as well as from books; but the book was important then as now, and the problem is to what scientific works he may have had access.

In this connection one naturally thinks of Alexander Neckham, an English scientist who did most of his work in the last two decades of the twelfth century. He was born in 1157 and was perhaps twenty years older than the Norseman who wrote the *Speculum*. Neckham was for some years a professor in the University of Paris, but his declining years were spent in an English monastery. He was born at Saint Albans, where the greatest English monastery was lo-

cated, and where the production and preservation of books was looked upon as a serious task. Saint Albans is near London, and if Ivar Bodde, as Heffermehl would have us believe, was the author of the *Speculum,* he may have collected his materials at Saint Albans and elsewhere when in England on diplomatic missions to the courts of John and Henry III. But even if this theory be rejected, the fact of intellectual and political relations with England in the thirteenth century remains undisputed. It was from Saint Albans that Matthew Paris set out to Norway in 1248, in the very decade when the King's Mirror seems to have been written. His mission was to reform and reorganize the monastery at Nidaros. It is significant that in this instance an Englishman was called in, not a German, or Fleming, or Frenchman.

Unfortunately, however, a study of Neckham's work, with a view to determining what sources the Norwegian author used, yields very slight results. The two works contain a considerable body of common materials, but in one instance only does it seem likely that the later writer has borrowed from the earlier. In speaking of earthquakes Neckham says:

> It is held that the winds force themselves into the caverns and passages in the earth's interior, and as they have no means of escape, they increase greatly in fury and strength.

And the Norwegian writer, in his account of the Icelandic marvels, tells us that earthquakes may be caused by volcanic fires; but he also offers another explanation. Down in the bowels of the earth there are probably a great number of large caverns and empty passages.

> And sometimes it may happen that these caverns or passages, either because of penetrating winds or the furious might of the ocean, are packed with wind till they cannot endure its violent movements; this may be the cause of those great earthquakes in Iceland.

It is of course possible that we have here only two statements of the same common belief; still, the parallelism is surprisingly close and leaves the suspicion that the Norseman knew Alexander Neckham's work.

On the other hand, the investigation leads to a conclusion which to the student of Northern culture is both interesting and satisfying. These two writers, Neckham and the anony-

mous Norseman, have summed up in part the scientific knowledge, each of his own generation. They were almost contemporaries, though the Englishman wrote early in his career while the Norseman probably wrote in the evening of life. At most Neckham's the *Nature of Things* is half a century older than the King's Mirror. The English scientist, who was the foster-brother of Richard I, had all the opportunities of his time: he had studied and taught at the University of Paris, the greatest educational center of the age. The Norseman, on the other hand, lived in the high latitudes of the far North somewhere north of the Throndhjem country, in the region which in those days was called Halogaland. Norway had no university and perhaps few higher schools. The age is usually represented as wild and fierce; the century opened with the civil wars still cursing the land, and there was little rest before a generation later when King Hakon had developed his great "king-thought." Nevertheless, the Norwegian writer proves the more accurately informed, the more truly critical, and the more modern in spirit of the two.

Medieval writers indulge freely in symbolic and mystical interpretations. So impressed were they with the sacred character of everything that the church did, believed, and stood for, that they readily found allusions to and suggestions of the sacred facts in everything in nature. Even Dante, who was born soon after the *Speculum* was written, indulges in this intellectual pastime. Alexander Neckham sometimes devotes fewer than half a dozen lines to the fact that he presents, and the remainder of the page to the Scriptural and mystical phases of it. In the three continents, Europe, Asia, and Africa, Neckham finds an unmistakable allusion to the Trinity. His discussion of the firmament is chiefly a comparison of its attributes with those of Holy Church. Of this there is almost nothing in the King's Mirror. The author states the facts as he understands them; Biblical illustrations are freely used, but as illustrations merely. He is modern also in this respect that he is willing to suspend judgment until evidence is forthcoming. He does not believe in rejecting a statement because it seems too marvelous; in this he resembled his great

contemporary Roger Bacon, who paid for his insight with long imprisonment; it may be that the fate of men like Bacon had something to do with the author's purpose to write anonymously. Nor does he like to believe without evidence. Many of his statements are given on the testimony of men who have actually seen and heard; but it is clear that he is not always satisfied with their statements. In this there is nothing strange: the medieval Northmen were not a credulous people. The author of the *Speculum* dislikes to speak of natural wonders, for, he says, many have a way of suspecting and disbelieving whatever they have not seen with their own eyes.

In one of his earlier paragraphs he sums up the chief subjects of a scientific character that a merchant ought to be thoroughly acquainted with: they are the great luminaries of the sky, the movements of the heavenly bodies, the divisions of time, the cardinal points of the compass, and the tides and currents of the ocean. In discussing these matters he cannot avoid referring to the form of the earth. All through the middle ages there were thinkers who accepted the belief of the Classical astronomers who had taught that the earth was round; but this belief was by no means general. From Neckham's use of terms we might infer that he, too, believed in a spherical earth; but nowhere does he commit himself. In his poem "In Praise of Divine Wisdom," he states that the "ancients have dared to think of the earth as round, although the mountains jut forth prominently." And where he argues that there must be water beneath the earth, he seems to be far from any thought of rotundity. For Paradise, which is the highest point of earth, it would seem, extends upward even past the moon.

As to what the King's Mirror teaches on this point, there is no doubt: the author uses the term "earth-sphere", *jarðarbǫllr,* in describing our own planet. In an effort to explain why some countries are hotter than others, he suggests an experiment with a candle and an apple. It is not clear how this can shed much light on the problem, but the author boldly states the point that should be illustrated: "from this you must conclude that the earth-circle is shaped like a ball."

It will be remembered that in the days of Columbus there was great fear of travel into the torrid zone, where the heat would grow stronger as one traveled south until a point would be reached where water would boil. This belief is also noted in the *Speculum,* but as a common superstition that the author wishes to demolish. He knows that the earth is divided by "belts" on the heaven into five zones; the extreme northern and southern cannot be inhabitated, and the same is true of the middle zone. But within any particular zone the temperature will differ according to location; Greenland lies close to the northern zone on the edge of things. But, says the son,

Every man who comes from the southern lands tells me that the farther south one travels the greater the heat; and the winds that come from southerly directions are both milder and moister than other winds.

To this the wise father replies:

You say that men tell us that the farther south one comes the greater the heat. That is because you have never met a man who has traveled as far south of the hot zone as those lands that we have discussed lie to the north of it.

The south winds are warm because they blow out of the hot zone.

And if there are people living as near the cold belt in the south as the Greenlanders to the one in the north, I am sure that the north-wind will come to them as warm as the southwind comes to us; for they must look northward to see the midday and the whole course of the sun, just as we who live north of the sun must look toward the south.

On the question of time and its divisions the author of the *Speculum* had all the information that the age possessed. The period of day and night is divided into twenty-four hours; each hour is again divided into smaller hours called in Latin *ostensa;* apparently there was no Old Norse word for minute. The length of the year is 365 days and six hours; every fourth years these extra hours make a day and we have leap year. There is an error here of about eleven minutes for each year, but this merely emphasizes the fact that the medieval astronomers made relatively accurate calculations. The waxing and waning of the moon and the tidal changes in the ocean were also reckoned with fair accuracy.

To Alexander Neckham the flux and reflux of the ocean is a mystery. It vexed the ancients, he tells us, and it vexes the moderns. Some have held that it was caused by a collission of two arms of the ocean, an eastern and a western.

> Others appear to ascribe these movements to certain cavern-like abysses which now swallow up water, now spew it forth again. The vulgar attribute them to the waxing and waning of the moon.

Neckham, as usual, refuses to commit himself and passes to an interesting parallel in the early persecutions of the church which rose and fell like the tides. The author of the *Speculum,* however, evidently believes that the tides are due to the influence of the moon.

In his discussion of volcanic fires, the Norwegian writer shows that he is still under the influence of medievalism. He has heard that Gregory the Great regarded the volcanic fires of Sicily as rising from the places of eternal torture. Our author is inclined to believe that the same is true of the fires of Iceland. He distinguishes between dead and living fire: the flames of Sicily are living, for they devour living things, such as wood and earth; those of Iceland, however, consume no such things, but only dead matter like rocks. And it is surely more likely that fire that arises from the realm of death would be a dead fire. Still, he does not insist that this is anything more than a conjecture:

> It is not necessary to accept this as perfect knowledge . . . .We have only tried to compare various things in order to find out what may seem the more likely. For we know perfectly that force or strength is the source of all fire. When one strikes hard iron and hard rock forcibly together, fire comes out of the iron and the force that is used. You can also rub two pieces of wood against each other in such a way that the labor produces fire.

Here the modern spirit is clearly apparent. There is something underneath the phenomenon, and the scientist concludes that the source of things, at least of fire, is force, or, as we should call it, energy.

The author is also interested in the strange polar lights and does his best to account for them. He has heard three theories proposed: some believe that the earth is encircled with light and that this is what appears in the polar lights;

others have held that these lights are simply rays of the sun that find their way past the sides of the earth while the sun is coursing underneath; the author, however, is inclined to believe that the frost and the ice have become so powerful in the Arctic that they are able to put forth light. His argument is not very convincing, still, it is an attempt to account for a mysterious phenomenon on the assumption that it is due to natural forces.

Medieval writers show an abiding interest in animal life. They were careful observers and noted their results accurately. The author of the *Speculum* has no occasion to discuss any beasts except those that inhabit the ocean. On the subject of seals and whales he appears to be thoroughly informed: he knows how these "fishes" are to be classified, what size they attain, and the commercial value of each class. So far as I know, the *Speculum Regale* is the only medieval document that gives an intelligent description of the monsters that inhabit the deep.

The question of the marvels that he has to relate, especially in his discussion of Ireland, is a perplexing one. Did this enlightened Norseman really believe that these wonders were genuine? Did he believe that apples actually had appeared on a willow tree in March, or that Irishmen in certain localities preserved their dead by setting them up against the church yard fence? It would not be strange if he did accept the current tales of wonders in distant lands; we must not forget that Henry Hudson saw a mermaid in the Arctic Waters nearly four centuries later. It is worth noting, however, that the author disclaims any serious purpose in relating these tales; we are told distinctly that they are for diversion only. Here and there we find a humorous touch that may indicate a little skepticism. Among the monsters of the Arctic is the Krake, a monster so huge and formless that it is sometimes mistaken for an island. The author does not deny the existence of the Krake, but so rarely is it seen, he tells us, that there can surely be only a few of them in existence, perhaps two only.

About one-third of the work is devoted to matters of scientific interest. The remainder deals with the higher life at

the royal court, the business of kingship, and the place of the church in the state. It was a dangerous thing for one who had lived through the pontificate of Innocent III to publish the belief that the church was practically subordinate to the state. We may here have another reason for the author's desire to remain unknown.

To a Norseman the King's Mirror is a work of great interest. But it should have a wider interest, for it is full of meaning for the history of the entire North. It was written in the most backward section of Scandinavia on the very edge of European civilization; and yet, it reveals a knowledge of the world, an appreciation of culture, and a liberal outlook that we should not expect to find in thirteenth century Norway. But if civilization had reached such a high point near the shores of the Arctic, what may we not believe as to the state of culture elsewhere in the North? It could scarcely have stood on a lower plane; perhaps it was of an even higher type. Thus the King's Mirror not only gives us the measure of Norwegian civilization,—it also permits us to infer what the minimum of culture must have been among the related peoples, the Swedes and the Danes.

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